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GEOLOGY AND PALÆONTOLOGY.

Contributions to the Knowledge of the Genus Pachyphyllum.—Up to 1870 the genus Pachyphyllum was not supposed by geologists to be represented in any of the American strata. But in 1870, Dr. White described a new species of coral from the Rockford shales, at Rockford and Hackberry, Iowa, as *Smithia woodmani* (Geol. Rep. Iowa, 1870, Vol. II., p. 188). This species was, however, afterwards shown to belong to the genus *Pachyphyllum*,[1] instead of the genus *Smithia*, to which it was at first referred. Again, in 1873, another new species of coral from the same beds was described by Hall and Whitfield,[2] as *Pachyphyllum solitarium*, intimating at the same time, however, that the specimen so referred differed from the generic description of *Pachyphyllum* in its being *solitary*. Since that time we have secured very large numbers of finely preserved specimens of this species, together with one new form from the same beds, as well as a

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[1] 23d Ann. Rep. Board of Regents of New York State Cabinet, p. 231.

[2] 23d Ann. Rep. Board of Regents of New York State Cabinet, p. 232.

presented by the author

closely allied new species from the blue shales below the Devonian limestone at Independence, Iowa. A critical study of all these forms showed them to be generically distinct from Pachyphyllum, and to constitute a new and well-marked genus. We have also personally collected from these shales three new specimens of Pachyphyllum, all of which are described in this paper, thus making four species of this genus known to occur in American strata.

The occurrence of the American representative of this genus only in the Rockford shales of Iowa[3] (so far as known) is a fact worthy of note. This fact, together with many others now in our possession, tends to widen the breach between its supposed equivalents, the Chemung group of Hall and Whitfield,[4] and the Hamilton group of Dr. White.[5]

Pachyphyllum woodmani White,—Compare with description of Hall and Whitfield; (23 Ann. Rep. New York State Cabinet, p. 231.) Coral variable; growing in irregular, flat, convex, hemispheric, oblong or semi-circular masses, from single beds three to four mm. in height to corallums twenty-five and one-half centimetres in diameter. Cell walls, more or less strongly exsert, projecting from less than one mm. to more than eleven mm. above the intervening spaces; from three mm. to one centimeter in diameter (the latter dimension, however, is very unusual). Very often situated at one extremity of the area, and rising perpendicular or obliquely to, or even lying flat upon, the surface of the inner cellular space; wall thin or of moderate strength; central depressions very irregular, circular, oblong or ovate in outline, from one and one-half to five mm. in depth. Rays numbering from twenty-five to forty-one, about half of which extend to the elevation or columella in the centre, while the remainder terminate just within the inner wall. Entire cell from three mm. to about two centimetres in diameter, partially limited by a wall formed by the coalescing of the costæ from the adjoining cells. Intercostal and interseptal spaces divided by numerous thin partitions. Usually the great size to which the exsert portion of the cells sometimes attains is at the expense of vertical height; and likewise when a great height is attained, it is at heavy cost to diametrical proportions. In isolated cases the under surface and margin of the corallum exhibit small patches of epithecal crust; and in still more isolated examples, where the exsert portion of

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[3] 23d Reg. Rep. New York State Cabinet, p. 236.

[4] Geol. of Iowa, 1870, Vol. I., p. 137.

[5] In some cases this genus is known to be represented in the Devonian limestone which immediately underlies these beds and, in one instance, adjacent to it.

the cell attains the greatest height, they are often annulated at the base and centre by epithecal rings; and budding often takes place slightly below the margin of the cell.

The usual method of growth of this species is by lateral budding almost from the beginning, but sometimes a single cell attains a height of from seven to twelve mm. before new cells are formed. This species, as well as all other species of this genus known to me, are, or were originally (with one known exception) attached to the surface of some shell or other species of corals. The delineation of this species is here based upon over two hundred finely preserved specimens. Its range is, so far as known to me, confined exclusively to the Rockford shales, except in some cases where it occurs in the limestone which immediately underlies them.

Pachyphyllum crassicostatum n. sp.—Coral, very coarse, growing in irregular, convex or slightly branching masses, from one and one-half to eleven centimetres in diameter; central depressions circular, from two to seven mm. in depth; wall very thick and strong. Entire cell from one and one-fifth to about two and one-fifth centimetres in diameter, usually limited by a wall formed by the uniting of the costæ of the adjoining cells; and again, this feature is not always well shown, owing to the great irregularity in growth of some specimens. Rays numbering from thirty-one to sixty, often only half of which extend to the elevated perpendicularly perforate columella in the centre, while the rest run out just within the inner wall. In large specimens the bottom of the cell is sometimes occupied by a well-defined, circular depression, instead of a columella. Rays and costæ continuous, passing down the outside of the cell wall and over the intercellular spaces. Intercostal and interseptal spaces divided by numerous thin, straight or convex transverse partitions.

The usual method of growth of this species is peculiar. Generally a large and very coarse curved cell will attain to the height (following the curvature of the specimen) of five and one-half centimetres or more before budding begins, which then takes place slightly below the margin of the cell, or some distance below. This description is from specimens from Owens' Grove, Cerro Gordo county, and Floyd, Floyd county, Iowa. Specimens of a variety of this species occur at Rockford and Hackberry; and differing from those from Owens' Grove and Floyd in the method of growth (which is generally by budding from the first) in that the coralla do not attain to so great a size, and the bottom of the cells never being occupied by a depression, as well as the (sometimes) slightly less coarse character of the

specimens. This species is known to occur only in the Rockford shales at Owens' Grove, Hackberry and Rockford, Iowa.[6] Although this species is not uncommon at the former locality, yet less than a dozen specimens have been secured from the two latter places during the thirteen successive years that we have collected from these shales. This is a fine species, and cannot well be confounded with any other described in this country.

Pachyphyllum ordinatum n. sp.—Coral compound, growing in regular convex, hemispherical masses, ten centimetres in diameter; point of attachment small. Cell walls abruptly but usually slightly exsert; generally projecting only one and one-half mm. above the intervening spaces; central depressions circular, very regular, three mm. in diameter (rarely a few small young cells are present); entire cells, quite uniform in size and of moderate dimensions, partially limited by a wall formed by the uniting of the costæ from the adjoining cells. Number of rays, from twenty-seven to thirty-two, most of which extend to the slightly elevated centre. Rays and costæ continuous, passing down the outside of the cell wall and over the intercellular spaces. Rays and costæ in well-preserved specimens, slender; but in weathered specimens, strong and broadly rounded or angular. The surface of each cell of this species is slightly concave; sometimes the exsert portion of the cell (which always occupies the centre of the entire cell) is sunk below the outer wall of the cell. This species varies much from *P. woodmani* in its general aspect, the concave surface and greater regularity of the cells, as well as in several other important particulars. Position and locality: Rockford shales, Hackberry, Iowa.

Pachyphyllum crassum n. sp.—Coral usually growing in concave or convex hemispherical masses, from two centimetres to eight centimetres in diameter. Cells usually large, walls strongly exsert, often projecting four mm. above the intervening spaces; central depressions quite regular, from three to five mm. in depth; entire cell from two centimetres in length to one and one-third centimetres in width; when this size is attained, however, it is at the expense of the adjoining cells. At times the large exsert portions of the cells are so crowded together that their bases unite; as many as seven of these projections or elevated portions of the cells have been observed in an area two and one-half centimetres square. Rays numbering from twenty-six to forty-

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[6] Since writing the above, a fine specimen has been secured by Mr. Guy Webster from the Devonian limestone which underlies the Rockford shales, one and one-half miles south of Rockford Grove, Floyd county: also numerous specimens have been secured by us from the same limestone at Floyd.

two, all of which appear to extend to the flattened or very slightly elevated centre. Rays and costæ continuous, passing down the outside of the cell wall and over the intercellular spaces. Rays and costæ down to the base of the cell walls alternating in size. The entire under surface of the corallum, except the point of attachment, covered by a strong, wrinkled, epithecal crust. This is a finely marked species, and differs in many important respects from its associate, *P. woodmani.* This species occurs in the Rockford shales, at both Rockford and Hackberry, Iowa.—*Clement L. Webster, Charles City, Iowa.*